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A SHORT DISSERTATION ON THE BAROMETER, THERMOMETER, AND OTHER METEOROLOGICAL INSTRUMENTS:

TOGETHER WITH AN

ACCOUNT

OF THE

PROGNOSTIC SIGNS OF THE WEATHER.

By GEORGE ADAMS, K

MATHEMATICAL INSTRUMENT MAKER TO HIS MAJESTY, AND
OPTICIAN TO HIS ROYAL HIGHNESS THE PRINCE OF WALES.

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PREFACE.

I HAVE, for ſome time paſt, thought of publiſhing a regular digeſt of what is at preſent known in Meteorology; a work which ſhould contain an arranged abſtract of the ſeveral treatiſes written on the ſubject by Meſſrs. De Luc, De Sauſſure, Van Swinden, La Cotte, Jones, Kirwan, &c. together with an account of the various inſtruments invented for exploring the ſtate of the atmoſphere; and a hiſtory of their improvements. But, as it would be ſome time before it could be prepared for public inſpection, as well from the nature of the work itſelf, as from my preſent engagements, I conceived a ſhort Diſſertation on the Barometer and Thermometer, with an account of the Prognoſtic Signs of the Weather, would be an acceptable preſent to my cuſtomers. To this idea, they are indebted for the following haſtily written tract. Of it's various imperfections, I am fully ſenſible; but I could not, conſiſtently with my other avocations, ſpare time to render it more perfect, or even to copy it fairly for the preſs: imperfect as it is, I have no doubt of it's being uſeful; that it will make many attentive to a ſubject which they have hitherto diſregarded; and that while it furniſhes a new fund of uſeful employment, it will tend alſo to advance the boundaries of ſcience. No branch of philoſophy is more intereſting than that which immediately concerns the conſtruction of that fluid which ſurrounds our globe, and

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is a principal agent in the moſt ſtriking operations of nature.

There are many, indeed, among the pretenders to ſagacity, who treat all prognoſtic ſigns of the weather with contempt; as fit only for the attention of rude and uncultivated minds. They may, however, be told, that the proceſſes continually carrying on by nature, on every ſide, and which are obvious to every eye, are as much the inſtruments of knowledge, as the more refined apparatus of the experimental philoſopher; that among the obſervers of ſigns and ſeaſons, men * are to be reckoned, who have given proofs of genius, that have not been equalled by all the efforts and wiſdom of ſucceeding ages. Theſe not only noted the phenomena of nature, but they attended alſo to the various prognoſtics of the weather; deſcribed them with accuracy; pointed out thoſe they thought moſt determinate; aad recommended it to others to compare the ſigns with the events, and correct one remark by another.

Meteorology is intimately connected with every branch of natural hiſtory, but more cloſely ſo with botany and agriculture. It is certain that much of the good qualities of plants, of graſſes, corn, fruit, &c. depend on the temperature of ſeaſons. The knowledge, therefore, of the effects of particular ſtates of the atmoſphere on vegetables, might probably lead us inſenſibly to account for ſome of the principal phenomena of vegetation; at leaſt, by enabling us, in ſome degree, to foreſee events, it would prevent many accidents, and remove much anxiety. To the obſervations on plants, ſhould be joined others on the appear-

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* Ariſtotle, Pliny, Virgil, &c.

appearance, departure, &c. of birds and inſects: for there is no inſulated fact in nature; they are all relative, ſyſtematic, or mechanical, having a double reference; as effects to their cauſes, and as cauſes to their effects. The material world is an immenſe body, compoſed of an infinite number of parts, ſo interwoven together, as to unite in one common center. It is the buſineſs of philoſophy to point out what apparently ſeparates theſe parts, and how they are connected; and to trace theſe connections to the principle of unity, which harmonizes and connects all the works of creation.

It is much to be regretted, that mankind, in endeavouring to avoid one error, are ſo prone to fall into the oppoſite extreme: this has been the fatal ſource of numerous errors. Thus, in order to avoid the hypothetical ideas of former philoſophers, thoſe of the preſent day are continually labouring to accumulate unconnected facts; remarks on links detached from nature's chains: theſe disjointed links, they twiſt and torture in ten thouſand different ways, and think every new form, or every new appearance, an important diſcovery; ſeldom endeavouring to trace out it's connection with ſuperior and inferior cauſes, on which alone all it's real powers and activities depend. Experiments are undoubtedly the ſure way of proving or diſproving any hypotheſis, and all hypotheſes ſhould be examined by them: but if we ſtop at them, without proceeding any further, we ſhall never come at any cauſes; and if they be wholly relied upon, without ſome better guide, we ſhall come at none but falſe ones; becauſe the principal agent in nature is ſo ſubtle as to elude both ſenſe and experiments; ſo that they can never diſcover it to us, though, when we have been told of it, they will ſerve to demonſtrate it's operations. The ſcience of nature has been too long improperly treated; it is now high time for us to return to plain and ſound obſervations on the phenomena which ſurround us; it is high time for us to conſider the agency of the elements: it is this agency which performs all the wonders in the theatre of nature; by it the univerſal ſyſtem, the life of individuals, the growth of plants, &c. are preſerved and ſupported.

The importance of this ſubject is ſo great, that I cannot refrain from ſubjoining the teſtimonies of two able writers in confirmation of the foregoing ſentiments. "It anſwers no purpoſe to conſider the motion of any ſingle body abſtractedly, as a thing by itſelf. If there is in fact no ſuch motion to be diſcovered, ſpeculations which carry us out of the world, can never teach us how things are conducted in the world. Nature is a ſyſtem of parts connected and related, and every particular part of it ſhould be conſidered under this relation; without which, neither the nature, nor deſign of it, can be underſtood. Matter, ſubſiſting as a part of the created world, has motion; but if ſeparated from the reſt, would have no more motion than a limb divided from the body: ſo that he who would underſtand the nature of motion, by taking matter abſtractedly, is ſtudying motion from that which has no motion belonging to it. If we proceed thus, we ſhall not only deceive ourſelves, but be great ſufferers, by loſing ſight of the true conſtruction of nature: and if we build a ſyſtem upon matter ſo independently conſidered,

ſidered, we ſhall raiſe ſuch a world as never did, or can exiſt; as empty and abſurd as it is arbitrary."*

"Men are generally ſolicitous to know the nature and cauſe of diſeaſes, of blemiſhes, of preternatural appearances in the body; but indifferent as to the proceedings of the healthy œconomy: we have an hundred diſſertations on fevers, for one upon life. The action of ſtimuli, and the irritability of the living fibre, have been the ſubjects of many ingenious diſcuſſions; the regular and uniform action of the fibre but of few.—It is the ſame in philoſophy: we have treatiſes on light, as ſeparated and divided by the priſm; on heat as meaſured by the thermometer: but none on that ocean of the ſolar fluid, in which all bodies are as it were immerſed; none upon the various influences of the ſun; upon which the life and activity of all things in this natural world depend. In the preſent mode of philoſophizing, what hope have we but of ſeeing new facts continually multiplied, by the indefatigable experimentaliſt: but no advance towards the knowledge of cauſes."†

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* Jones's Phyſiological Diſquiſitions.

† Young's Eſſay on the Powers and Mechaniſm of Nature.

WORKS

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THERE is ſcarce any ſubject in which mankind feel themſelves more intereſted than in the weather, the temperature of the air, and the influences of wind and rain; which is evident, from it's conſtantly forming a principal topic of their converſation. The traveller endeavours to regulate his motions, and the farmer his operations, by the weather: by it, plenty or famine is diſpenſed, and millions are furniſhed with the neceſſaries of life.

Notwithſtanding it's importance, our actual knowledge of the atmoſphere is blended with much uncertainty, and, in many inſtances, enveloped in obſcurity; yet enough is even now known, to enable us to obviate danger, and avoid inconvenience. The ſpeculative philoſopher contemplates with pleaſure the changes in the weather, changes that preſent the mind with ſome of the moſt wonderful among natural effects, all working with boundleſs variety, for the good of the world and it's inhabitants.

Among the various conſiderations that tend to mortify pride, and humble arrogance, there is perhaps none more ſtriking than the reflection that the moſt brilliant labours of men are ſeldom the moſt uſeful; but, on the contrary, are often of great diſ-ſervice, both to the preſent and future generations; yet theſe are admired, while the humble labours of thoſe, by whom ſcience is advanced, and civilization gradually diffuſed, are looked upon with contempt by the ſlave of ambition and the man of genius.

It is, however, only by aſſiduous obſervation, and patient inveſtigation of the conſtitution of the air, the variations in the weight of the atmoſphere, a regular hiſtory of the winds, of the rain, and the changes of heat and cold, that we can ever expect to diſcover the connection of thoſe phænomena in the atmoſphere, which now appear to be unconnected and without order. Furniſhed with theſe data, we might, perhaps, be enabled to follow the courſe, and predict the changes of the elements, with as much certainty as we now do thoſe of the planetary bodies.

If every one, who is in poſſeſſion of meteorological inſtruments, would keep a diurnal regiſter of the ſtate and of the correſponding phænomena of the atmoſphere, and tranſmit the reſult of his obſervations to the public, he would contribute more to the advancement of this branch of ſcience, than he might at firſt imagine. While he was amuſing himſelf, and only gratifying curioſity; he would be promoting knowledge, and probably procuring benefits for poſterity. Let no one ſuffer the apparent improbability of ſucceſs, to diſcourage him from the attempt. Let him remember that ſcience advances by ſlow and gradual ſteps, that it's progreſs depends on the cultivation of the mind, the removal of obſtacles, and the exertions of individuals; that the preſent is ever pregnant with the future, but the connections between them can only be found by long attention and diligent obſervation.

There is great reaſon to hope that meteorology will ſoon be very much improved, from the zeal with which it is now cultivated; the more ſo, as Charles Theodore, Elector Palatine of the Rhine, has erected an academy, ſolely dedicated to meteorological inquiries, and has ſent inſtruments, fabricated at his own expence, to all the academies and univerſities of Europe, willing or able to undertake the taſk of employing them.

Meteorological phænomena, like all the durable motions of the world, depend upon A CIRCULATION of matter.— Here it is carried on by a changing of water into a new, and a regeneration of it into it's primitive form again. It goes off from the ſurface of the earth in the form of a rare, inviſible, expanded vapour, perfectly diſſolved in the air as a menſtruum, being ſuſpended for ſome time in this ſtate; it is afterwards condenſed into miſt and clouds, then gathered into drops, when it falls, and in this form it returns to the place from whence it came, to take it's turn once more in the common courſe of evaporation, and be again, and again, circulated to the great promptuary of the world.

The principal objects of inquiry are, therefore, 1ſt, In what manner the atmoſphere is ſupplied with HUMIDITY? The 2d, WHAT CAUSES and WHAT PREVENTS this inviſible humidity from being formed into viſible clouds? And 3dly, WHAT PREVENTS and WHAT CAUSES the viſible clouds to be precipitated in rain? To know the BALANCINGS OF THE CLOUDS? How ſuch ponderous bodies are ſuſpended in the fluid ether? And how THE WATERS ARE BOUND UP IN THE THICK CLOUD?

Meteorological inſtruments are, 1. A Barometer: 2. A Thermometer: 3. A Hygrometer: 4. A Rain Guage: 5. An Electrometer: 6. An Anemometer: 7. An Evaporation Guage.

OF THE BAROMETER.

In 1643, Toricellius, by one happy and deciſive experiment, diſcovered the barometer, and proved the preſſure of the atmoſphere. For on filling a tube of glaſs 36 inches long, and hermetically ſealed at one end with quickſilver, and then plunging the lower and unſealed end into a baſon of the ſame fluid, he obſerved that a column of quickſilver of about 30 inches remained in the tube. He compared this to the height to which water is elevated in pumps, and found that the heights were in an inverſe ratio of the ſpecific gravities of water and mercury, which led him to think they were ſupported by the ſame counterweight; and on examining the ſeveral circumſtances, he found this counterweight was the air: hence this inſtrument was called a barometer. To this inſtrument philoſophy is indebted for the greater part of what is known concerning the weight and elaſticity of the air: for though mankind had been always preſſed and acted upon by this weight, and a thouſand phænomena bore witneſs to it's exiſtence, yet it's power was not known, nor it's influence acknowledged, till the laſt century.

GENERAL IDEA OF A BAROMETER.

Take a clean glaſs tube about 33 inches long, ſealed at one end, and open at the other, fill it perfectly with pure quickſilver, then ſtopping the open end with the finger, invert the tube, and plunge the open end into a ciſtern of quickſilver; after which, elevate the tube till it be perpendicular, and the mercury will deſcend, and ſubſide at a certain diſtance from the top, more or leſs, according to the ſtate of the air at the time of making the experiment.

The ſpace vacated by the mercury at the top of the tube having no air in it, the external air preſſes upon the quickſilver in the ciſtern, and ſuſtains, by a preſſure in a contrary direction, a column equal in weight to itſelf. For it is evident that the mercury endeavours to deſcend with a force equal to that by which it's deſcent is prevented. In other words, the preſſure of the atmoſphere on a given ſurface is equal to the weight of a column of mercury, whoſe baſe is the given ſurface, and height that which it ſtands at in the barometer; but the preſſure of the atmoſphere is the weight of a column of air, whoſe baſe is the given ſurface, and height equal to that of the atmoſphere. The height of the mercury is therefore an adequate meaſure of the weight or preſſure of the air, upon a ſurface equal to that of the baſe of the tube containing the mercury.

Such was the firſt barometer as invented by Toricellius: ſince his time, the mode of filling it, ſo as perfectly to exclude the air from the upper part, and many other neceſſary circumſtances for conſtituting a good barometer, have been explored with diligence by ſome of the moſt eminent modern philoſophers. Various methods have been contrived for enlarging the ſcale of the barometer; they are, however, all of them replete with error; and though, in point of form, ſome among them may appear more elegant than the plain barometer, yet they cannot be depended on for keeping an accurate regiſter of the weather, or for obſerving the extent of the variation in any given ſituation, or comparing the different changes at one place with correſponding ones at another.

OF SOME OF THE PRINCIPAL REQUISITES OF A GOOD BAROMETER.

The limits to which I have confined myſelf in this tract, will preclude me from entering minutely into this ſubject; I mean to conſider it fully in my Meteorological Eſſays, touching here only on one or two of the more eſſential circumſtances.

1. It is requiſite that the height of the column of mercury be altered by no other cauſes but the changes that ariſe from the preſſure of the air, and that theſe changes be truly indicated.

2. That the variations in the height of the column be aſcertained by a known meaſure.

3. That the column of mercury be ſuſceptible of the ſmalleſt alterations in the weight of the air.

In order that the column of mercury, in the tube, may be affected by no other cauſe than the preſſure of the air, it is abſolutely requiſite, that the upper part of the tube, and the mercury itſelf, be entirely freed from air; for if there be any air between the upper ſurface of the column of mercury and the ſealed end of the tube, it will be the ſource of many errors and much irregularity. The included air will act as a counterpoiſe againſt the weight of the atmoſphere, and to a certain degree counteract it's preſſure, and, therefore, render the indication of the inſtrument uncertain and erroneous. This included air, being alſo often combined with humidity, expanded by heat, or contracted by cold, acts differently at different times; the only method of preventing theſe errors, and perfectly excluding the air from the barometer, is by boiling the mercury in the tube: an operation which is carefully performed in all the beſt inſtruments.

That the changes in the height of the mercurial column may be truly aſcertained, it is neceſſary to know at all times the exact diſtance of the ſurface of the mercury in the tube, from the ſurface in the reſervoir or ciſtern.

The firſt point of the meaſure muſt commence from the ſurface of the mercury in the ciſtern; but this ſurface is variable, for when the mercury deſcends, a quantity of it falls into the baſon and raiſes the ſurface thereof; and on the contrary, when it riſes, a quantity is taken out of the ciſtern, and the ſurface thereof is lowered. The ſcale of inches to the barometer is fixed; but the ſurface of the mercury in the ciſtern from which it originates is continually varying. To remedy this evil, it is neceſſary that the lower ſurface ſhould be always kept at the ſame height from the diviſions on the ſcale affixed to the inſtrument. This is effected by means of a floating guage, which was firſt applied to the barometer by MY FATHER, though others have, ſince his time, aſſumed the merit to themſelves. By means of the floating guage, the ſame ſcrew that renders the barometer portable, regulates the ſurface of the mercury in the ciſtern, ſo that it is always at the place from whence the diviſions on the ſcale commence. This guage is never applied to the common portable barometers, but only to thoſe of the beſt kind. The manner of uſing this guage will be deſcribed in a ſubſequent part of this tract.

Another circumſtance neceſſary to be attended to in very accurate obſervations, is the effect of heat and cold on the barometer, as by theſe the mercurial column is either dilated or contracted; for as all bodies expand and occupy larger ſpaces when their temperature is increaſed, the mercury in the barometer will, when heated, be ſpecifically lighter, and will conſequently aſcend from that cauſe, though the preſſure of the air ſhould remain unchanged ; and that, therefore, in order to know accurately the effect of the air's preſſure on the barometer, it is neceſſary to correct the height by the addition, or ſubtraction of a quantity equal to the influence of the temperature of the air thereon : for this purpoſe, a table is ſubjoined to this deſcription. In ſome caſes a ſcale of correction is applied to the thermometer accompanying the barometer, and which is indeed a neceſſary companion to it.

2d. Condition. That the ſcale ſhould be of ſome known meaſure. It would have been totally unneceſſary to have mentioned this condition, had it not been to prevent thoſe, into whoſe hands this tract may fall, from being impoſed upon by venders of imperfect inſtruments. Some of theſe inſtruments have no determinate ſcale affixed to them ; and thoſe which have a ſcale, have one that is in general ill graduated and erroneouſly placed, ſo that no comparative obſervations can be made with them ; and often, indeed, no obſervation at all ; as from the ſmall bore of the tube, they act as a thermometer, as well as a barometer. We have already obſerved, that by enlarging the ſcale, error is multiplied, and uncertainty produced.

3d. Condition. That the ſmalleſt changes in the height of the column of mercury may be diſcerned.

To meaſure the ſmalleſt changes, a nonius diviſion moves with the index, by which each inch is ſubdivided into 100 parts, and the height of the mercury is accurately obtained without any danger from parallax, by the peculiar conſtruction of the index.

OF THE NONIUS.

The ſcale of inches is affixed to the right ſide of the tube, the zero or beginning of the ſcale being at the ſurface of the mercury in the ciſtern, the index and it's nonius plate ſlide up and down in a groove, which is parallel to the line of inches, that the index may be ſet at any time to the upper ſurface of the column of mercury.

Each inch, or line of inches is divided into ten parts, which are again ſubdivided into ten, by means of the nonius ſcale; the whole inch being thereby divided into 100 equal parts.

TO READ OFF, OR ESTIMATE THE DIVISIONS OF THE NONIUS SCALE.

1. If that edge of the nonius ſcale, which is in a line with the index, coincides exactly with any diviſion on the line of inches, that diviſion expreſſes the height of the index from the ſurface of the mercury in the ciſtern, in inches and tenths of inches. But 2dly, If the foregoing edge does not coincide with any diviſion, you muſt look for that diviſion of the nonius, which coincides with a diviſion in the line of inches, and the number on the nonius ſhews how many tenth parts of the tenth, the index or edge has paſſed the laſt decimal diviſion. Thus for example, ſuppoſe the edge of the nonius was to point ſomewhere between 29 inches 8 tenths, and 29 inches 9 tenths; then if by looking at the nonius, you obſerve

the coincidence at 5, it ſhews the altitude to be 29 inches 8 tenths, and 5 parts of another tenth, or 29, 85.

Accurate obſervers do not eſtimate the height of the mercurial column by the edge of the mercury that is in contact with the interior part of the glaſs tube;* becauſe the attraction of the glaſs prevents, in ſome meaſure, that part of the mercury which is in contact with it from obeying immediately the preſſure of the atmoſphere, while the middle part of the column being but little, if at all affected by this attraction, is undoubtedly the trueſt meaſure; and is, at the ſame time, the moſt ſenſible of every change in the preſſure of the atmoſphere. In order to aſcertain the exact height of the upper part of this convex ſurface, beſides the index on one ſide of the glaſs tube, there is another placed directly oppoſite thereto behind the glaſs tube; in ſuch manner, that if a plane was to join the lower edges of theſe indices, it would be at right angles to the direction of the glaſs tube; and the eye being placed in this plane, the index is to be raiſed or lowered, till it's lower edge, and alſo that of the index behind the tube, appear to touch the top of the convex ſurface of the mercury in the glaſs tube; or in other words, that an imaginary plane joining the lower edges of the indices, may appear as a tangent to the convex ſurface of the mercury, and the nonius will give the height of the mercurial column. This improvement of the indexes is one, among many, for which ſcience is indebted to Mr. Ramſden.

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* Deſaguliers.

OF THE COMMON PORTABLE BAROMETER.

This inſtrument, when made with care, will anſwer for general and domeſtic obſervation, but is not ſufficiently accurate for philoſophical purpoſes. It conſiſts of a tube, of a proper length, accurately filled with mercury; the lower end of the tube is glued to a wooden reſervoir, the bottom of which is formed of leather; into this reſervoir the ſuperfluous mercury deſcends, and the air, by preſſing upon the flexible leather at the bottom of the reſervoir, keeps the mercury ſuſpended at it's proper height. This reſervoir is concealed from the eye by a neat mahogany cover, or box. This tube and reſervoir are placed in a frame, on the upper part of which is a ſilvered braſs plate; on the right-hand ſide of this plate is a ſcale of inches, reckoned from the ſurface of the mercury in the ciſtern; each inch is divided into ten parts. Cloſe to the line of inches there is a ſlit, or groove, for conveniently ſliding the nonius ſcale and index up and down. The upper edge of the index and nonius ſcale are in a line. It is the upper edge of the index that is to be ſet to the upper ſurface of the mercury. On the left-hand ſide of the plate, the words FAIR, CHANGEABLE, RAIN, are engraved. At the bottom of the frame there is a ſcrew paſſing through the mahogany box which covers the reſervoir: a flat round plate is placed upon the end of the ſcrew within the box; this end is deſigned to preſs upon the leather bag, and force the mercury up to the top of the tube, and thus prevent it from ſhaking, or violently ſtriking againſt the top of the tube when tranſported from one place to another.

TO USE THE PORTABLE BAROMETER.

1. Suſpend it againſt a wall, or wainſcot, ſo that the tube may be perpendicular to the horizon.

2. Unſcrew the ſcrew at the bottom of the frame as low as it will go, and the mercury will fall to it's proper height, and be obedient to the changes in the weight of the air.

3. Set the upper edge of the index, ſo as to coincide with the ſurface of the mercury in the tube, and the nonius ſcale will point out the height of the column.

4. Before every obſervation, ſtrike the frame gently with the knuckles, to diſengage the quickſilver from the tube.

5. If the barometer is to be moved from one place to another, turn the ſcrew, till the mercury is preſſed by it againſt the top of the tube.

DEFECTS OF THE COMMON PORTABLE BAROMETER.

It is neceſſary here juſt to mention ſome of the defects of this kind of barometer, in order to render the advantages of the better kind more conſpicuous.

1. It cannot be ſo adjuſted as to be ſure that the diviſions on the ſcale are at that height from the mercury in the ciſtern, which is expreſſed by the numbers affixed to them.

2. As when the mercury falls in the tube, it riſes in the reſervoir; and when it riſes in the tube, it falls in the reſervoir: it's diſtance is perpetually varying from the diviſions of the ſcale.

3. The tenſion of the leather forms a conſiderable reſiſtance to the preſſure of the atmoſphere.

OF THE BEST PORTABLE BAROMETER.

This barometer, like the preceding, conſiſts of a glaſs tube, properly filled with mercury, having the lower end fixed to a wooden ciſtern, with a leather bottom, and this tube and ciſtern placed in a mahogany frame.

On the upper part of the frame a braſs plate is placed; on the right-hand ſide of the tube a ſcale of inches is graduated on the plate, the beginning of the ſcale being at the ſurface of the mercury in the ciſtern: each inch is divided into ten parts, which are again ſubdivided into tenths by the nonius ſcale.

The nonius plate carries two indexes, exactly ſimilar to each other, one placed before the tube, the other behind it. The indexes may be raiſed or depreſſed, by turning the key, which fits into a ſmall hole in the frame, directly under the groove of the nonius plate.

On the left-hand of the tube a ſmall thermometer is placed, with Fahrenheit's ſcale; there is an index to the thermometer, which may be ſet by the ſame key as the barometer, only putting it into the ſmall hole under the thermometer, and turning it round till the index points to the mercury in the thermometer. A ſcale for correcting the expanſion of the mercury in the barometer, is often graduated cloſe to the ſcale of the thermometer.

The upper part of the barometer is covered with a glaſs plate, to prevent the ſilvering of the plate from being injured by dirt, or being corroded by the action of the air.

OF

OF THE LOWER PART OF THE BAROMETER.

The lower end of the tube is immerſed in the ciſtern which contains the mercury; the ciſtern is covered with a mahogany box; at the bottom of the frame is a ſcrew, to raiſe or lower the ſurface of the mercury; at the top of the ciſtern is a hole, which is fitted with an ivory ſcrew, to be placed there occaſionally for the conveniency of tranſporting the inſtrument ſafely from one place to another.

The guage conſiſts of a ſmall ſtem of ivory, ariſing from a float of the ſame ſubſtance; a circular diviſion is cut round this ſtem; the ſtem paſſes through a ſhort cylinder of ivory, which is cut open in front; on this front two ſmall diviſions are cut; at the bottom of this cylinder is a male ſcrew, to fit the female ſcrew of the ciſtern; the upper part of the guage is protected by a tube of glaſs perforated at top.

TO USE THIS BAROMETER.

1. The barometer being fixed in a perpendicular poſition, unſcrew the ſcrew at bottom as far as it will go without forcing it.

2. Take out the ivory ſcrew at the top of the ciſtern, and place it between the ſcroles on the upper part of the frame.

3. Screw the guage into the place from whence the ivory ſcrew was taken.

4. Screw up that ſcrew which is at the bottom of the frame, until the line on the float exactly coincides with the two lines on the front of the ivory cylinder.

5. Strike the barometer gently with the knuckles, and then ſo ſet the lower edge of the front index to the convex ſurface of the mercury, that it may be at the ſame time in a line with the edge of the index behind the tube; and the nonius will then give the true height of the mercurial column, from the ſurface of the mercury in the ciſtern.

6. The preceding rule for ſetting the guage muſt be complied with, previous to every obſervation.

7. If the barometer is to be tranſported from one place to another, the guage muſt be removed, and the ſolid ivory ſcrew inſerted in it's place; after which, the mercury in the tube may be forced gently up to the top thereof, by the ſcrew at the bottom of the frame.

OF THE SCALE OF CORRECTION.

This ſcale is placed cloſe to that of the thermometer; but on the right-hand ſide, the zero, or 0 degree of this ſcale, correſponds to the 55th degree of the thermometer.

1. If the barometer is at 30 inches, and the thermometer at 55 degrees, no correction is neceſſary.

2. But if the thermometer be under 55, and the barometer at 30 inches, you muſt add to the height of the barometer as many of the 100ths of inches as are on the ſcale of correction oppoſite to the degree of the thermometer.

3. If the thermometer be above 55, and the barometer at 30 inches, you muſt ſubtract as many 100ths as are indicated by the given degree of the thermometer on the ſcale of correction.

4. The ſcale applied to the thermometer anſwers for the general range of meteorological obſervations; but if

the height of the barometer be very far diſtant from 30 inches, it will be neceſſary to make uſe of the rule of three, in order to obtain the true correction: for inſtance, let the barometer be at 26 inches, which we will call P, c the correction indicated by the thermometer, x the true correction: then as 30 : P :: c : x; or $\frac{Pc}{30}=x$, which is to be added to the height of the barometer whenever the thermometer is under 55 degrees, but to be ſubtracted when it is above 55.

OF THE

THERMOMETER.

HEAT and COLD are perceptions of which we acquire our ideas from the ſenſes: though, properly ſpeaking, theſe ideas only indicate a certain ſtate, in which we find ourſelves independent of any exterior object.

But as theſe ſenſations are, for the moſt part, produced by ſome of the bodies which ſurround us, and as they are generally accompanied in theſe bodies by an augmentation or diminution of what we call FIRE, we conſider them as an effect of fire, and judging by appearances, we apply the names hot and cold to the ſubſtances themſelves, calling thoſe hot which produce in us the ſenſation of heat, and thoſe cold which communicate the ſenſation of cold to us. Whatever be the nature of that quality in bodies which we call heat, we are aſſured that it does not reſemble the ſenſation of heat. It is no leſs abſurd, to ſuppoſe a likeneſs between the ſenſation and the quality, than it would be to ſuppoſe that the pain of the gout reſembles a ſquare or a triangle. The ſimpleſt man, with common ſenſe, never imagines the ſenſation of heat, or any thing that reſembles it, to be in the fire: he only imagines that there is ſomething in the fire which makes him feel heat. But as the name heat more frequently ſignifies this unknown ſomething in the fire, than the ſenſation occaſioned by it, he juſtly laughs at the philoſopher who denies that there is any heat in the fire.

But the contradiction between the philoſopher and the vulgar is more apparent than real, and is owing to an abuſe of language on the part of the philoſopher, and to indiſtinct notions on the part of the vulgar. The philoſopher ſays there is no heat in fire, meaning that the fire has not the ſenſation of heat: his meaning is juſt, but his language is improper; for there is really a quality in fire, of which the proper name is heat, a name given to this quality both by the philoſopher and the vulgar, more frequently than to the ſenſation of heat; and when he explains himſelf, and ſays that the fire does not feel heat, the difficulty vaniſhes, and the vulgar will agree with him.

But our ſenſations depend not only on the ſubſtances which excite them, but on the actual ſtate of our bodies at that time: we cannot, therefore, conclude the exact identity or ſimilarity of the cauſe, from the ſameneſs of the ſenſations, unleſs we can be aſſured that our bodies are in the ſame ſtate: if they be not, the ſame objects will produce very different ſenſations. Thus, if the hand be plunged into lukewarm water, this water will appear cold if the hand be warm; but if the hand be cold, the water will appear to be warm; though in both caſes it poſſeſſes the ſame temperature.

Our ſenſes are, therefore, both imperfect and deceitful meaſures of heat; and we cannot aſcertain, by their means only, the ſtate of the ſurrounding bodies with reſpect to heat or cold. This occaſioned philoſophers to ſeek for ſome method by which they might determine the temperature of bodies with more certainty. This they found in the property of heat, to dilate and expand all bodies, whether ſolid or fluid; and of cold, to contract or condenſe them. This expanſion and contraction is conſidered as a meaſure infinitely more certain of the degrees of heat and cold, than the ſenſes.

It would appear from this expanſion, that fire, when it is agitated by that motion which we call heat, always acted as if it wanted more room, and this in ſuch a wonderful manner, as if every particle of ſpace in which it exiſts were a radiant point or center, from whence it ſpreads forcibly outwards in every direction; and conſequently when fire, thus acting, is admitted into the pores of bodies, their parts muſt be ſtretched out, and their dimenſions every way increaſed, according to the degree of fire by which they are acted on. Some idea of the force of this expanſion may be gained by conſidering how vaſt a weight may be ſuſpended from a bar of iron, or braſs, in a vertical poſition, without ſeparating the parts of the metal, or overcoming the force with which they cohere. Now this, fire eaſily executes, ſo far relaxing the texture of braſs and iron, that their parts will fall aſunder with nothing but the force of gravity.

Thermometers are inſtruments which meaſure the degree of heat by the expanſion of bodies. Fluids are thoſe generally uſed, becauſe they are dilated more readily than ſolids; and quickſilver is preferred to other fluids, becauſe it's expanſibility is not affected by the different circumſtances in which it is placed; it does not ſoil the tube like many other fluids, and at the ſame time affords an extenſive ſcale of diviſions.

A thermometer is a tube of glaſs, the end of which is blown into a ball or cylinder; the ball, and part of the tube, is filled with mercury. The fluid in the ball dilates by the heat, and contracts with the cold, which occaſions the fluid in the tube to riſe and fall; and the ſmaller the bore of the tube is in proportion to the ball, the more viſible will be the riſe of the fluid by a ſmall expanſion. We may, therefore, conſider this inſtrument as a convenient meaſure of the changes of heat and cold, which is ſhewn by the ſcale to which the tube is affixed.

But it is not ſufficient to have found a meaſure of heat; it muſt be univerſal, always ſpeaking the ſame language, and awaking the ſame ideas in the mind, in all places, and at all times.

To this end it is neceſſary, 1. That this meaſure ſhould begin from a known and determinate point. And, 2. That another point, equally certain as the firſt, but at ſome diſtance from it, be fixed upon. And, 3. That the ſpace between them may be divided into a certain number of parts, which in all inſtruments will have a conſtant proportion.

It has been fully proved that the temperature of freezing water, or melting ice, is conſtantly the ſame in all places, and at all times. The ſame may be ſaid of boiling water, under a given preſſure of the atmoſphere. If, therefore, the ball of a thermometer be plunged into melting ice, and afterwards into boiling water, and left in each till it acquires their temperature, and marks are made at the reſpective heights at which the mercury ſtands in each, two fixed points will be obtained.

Fahrenheit's ſcale is that which is uſed in England: the freezing point is called 32, the boiling water point 212; ſo that there are 180 degrees, or diviſions, between them, which may be extended upwards and downwards, as far as is neceſſary.

Foreigners uſe Reaumur's, or rather De Luc's ſcale, where the freezing point is called 0, and the boiling water point 80.

In a good thermometer it is neceſſary, 1. That the ſpace between the mercury and the ſealed end of the tube be free from air. 2. The fixed points muſt be accurately aſcertained. 3. The ſcale ſhould be divided according to the capacity of the tube.

Two thermometers are neceſſary for accurate obſervation; one to be ſuſpended within doors, near the barometer; the other out of doors. That without doors ſhould be placed at the north ſide of the houſe, or where it will be ſheltered from the rays of the ſun.

OF THE

HYGROMETER.

THE hygrometer is an inſtrument intended to diſcover the ſtate of the air with reſpect to humidity, or dryneſs.

Had we indeed an hygrometer which would ſhew with accuracy the moiſture of the air at different altitudes, we ſhould be forward in our way towards prognoſtication.

The author of nature has, however, kindly furniſhed us with natural hygrometers, namely, the riſing and ſetting luminaries; and even when they have riſen to a conſiderable altitude, an attentive obſerver may conſider them as hygrometers. Perhaps a bright ſcorching ſun, a lucid moon with ſharp horns, and lively twinkling ſtars, denote a dry air: while a faint ſun and ſtars, and the moon blunt, as alſo the lunar and ſolar rings, may indicate a moiſt air.

As the whole atmoſpheric œconomy, as far, at leaſt, as relates to the weather, depends upon, or is connected with the ſtate of the vapour it contains, it is rather ſurprizing that we find ſo few hygrometrical obſervations among the many meteorological diaries that have been publiſhed. From time immemorial, the effects of moiſture have been conſidered as prognoſtic of the weather, as is evident by the confidence the houſewife places in her ſalt-box, the carter in his whit-leather thong, and the ſailor in his ſhrouds.

But whether the hygrometer be a prognoſtic or not of the weather, it is certainly of the utmoſt importance to the natural philoſopher, and would probably prove a valuable oracle to the farmer, which is fully evinced by the following obſervation of Mr. Marſhall, in his minutes of agriculture. "Yeſterday morning, (ſays he) while the hygrometer ſtood at 2 degrees moiſt, the peas were by no means fit for carrying; the halm was green, and the peas ſoft. About ten o'clock the hygrometer fell to 1 degree dry; before one the peas were in good order: I went up into the field, merely on the WORD of the hygrometer, and found the peas fit to be carried." It is plain, therefore, that on a ſcattered farm, in hay-time and harveſt, an hygrometer muſt be peculiarly uſeful.

Within theſe few years, Meſſ. De Luc and De Sauſſure have conſidered, with great attention, the ſubject of hygrometry, and have publiſhed three volumes on hygrometers, and the phænomena connected with them: they have alſo, each of them, contrived inſtruments for the purpoſe of aſcertaining the moiſture of the air. That of Mr. De Sauſſure is probably the beſt; the moving principle is a human hair: they have not been made in England, 1. On account of the trouble attending the neceſſary preparation of the hair. 2. On account of it's fragility. Mr. De Luc's, though more defective in conſtruction, is made with more eaſe, and is leſs liable to accidents. In my meteorological eſſays I mean to give a full account of theſe inſtruments, and the ſubſtance of the works of their reſpective inventors.

There are two other hygrometers in uſe, one made of the beard of a wild oat, the other of hatters paper.

OF THE
UDOMETER,
OR
RAIN GUAGE.

IT is as neceſſary towards forming a ſyſtematic idea of the weather and it's various changes, to meaſure the quantity of rain which falls upon the earth, as to know the different degrees of heat and cold, or the variations in the preſſure of the atmoſphere.

The rain guage is a very ſimple inſtrument, conſiſting of a tin funnel of twelve inches diameter, communicating with a tube or cylinder of tin, into which the rain is conveyed by the funnel. The heighth of the water is meaſured by a rule fixed to a float; this rule paſſes through the center of the funnel.

To uſe the rain guage, ſo much water ſhould be firſt poured in as will raiſe the float, ſo that the zero, on the rule, may exactly coincide with the aperture of the funnel. The funnel is ſo contrived, as to prevent the water from evaporating.

This guage ſhould be fixed down firmly in a place where, whatever wind blows, the fall of the rain may not be intercepted by the houſe, or any other impediment.

ELECTROMETER.

For a deſcription of this, I muſt refer to my eſſay on electricity.

OF THE

ATMIDOMETER.

THE atmidometer is an inſtrument for meaſuring the abſolute quantity of water raiſed in vapour, at different ſeaſons, and in different years: or to know from evaporation, at any given time, the diſſolving power of the air at that time, or the quantity of water exhaled and abſorbed by the atmoſphere.

The atmidometer conſiſts of a cylindrical veſſel, of 12 inches diameter, with a glaſs tube of four or five feet, proceeding from the bottom in a diagonal direction, the top of the tube being level with the top of the veſſel; by this contrivance the ſmalleſt variations in the ſurface of the water are readily diſcovered.

There is a cover to the guage, at ſome diſtance from the ſurface, to prevent rain falling into it.

OF THE ANEMOMETER, OR *WIND GUAGE.*

AS no accurate inſtrument has been contrived for meaſuring the force of the wind, the purpoſes of meteorology will be anſwered, by regiſtering the quarter it blows from by a common vane, with the following diſtinctions, gentle air, briſk wind, freſh gale, hard gale, a ſtorm, violent ſtorm, hurricane.

When there are detachments of clouds, with a mixture of ſun-ſhine, the velocity of the wind may be traced by their ſhadows along the ground. In ſtorms, if the wind rages by violent guſts at intervals, a grove of trees may be ſeen to bend under the force; and if it's courſe be attended to, other trees, at a ſufficient diſtance, may be ſeen to bend under the ſame blaſt; ſo that the ſpace run over in a given time may be nearly diſcovered.

ON PROGNOSTIC SIGNS OF THE WEATHER.

By the weather we mean the various circumſtances and phenomena attendant upon vapours, miſts, clouds, rain, hail, ſnow, froſt, thunder and lightning, the aurora borealis, and the winds.

The ſtate of the atmoſphere is influenced and modified by the variations in it's denſity or weight; by the quantity of aqueous particles, or it's humidity; by it's tranſparency, or the inviſibility of the aqueous particles; by the viſible collection of them in clouds, by their precipitation in rain, by the wind, by the agency of electricity, and the action of heat and cold.

There is no part of meteorology which intereſts mankind ſo much, as the predictions it furniſhes of the change of weather. The theory of it only engages the attention, by animating us with the hopes of thereby bringing the knowledge of their predictions to perfection.

And the far greater part of thoſe who purchaſe meteorological inſtruments, buy them, not ſo much to know the actual ſtate of the elements, as to foreſee the changes thereof. This ſcience is, however, very imperfect; for it is but of late years that we began to make obſervations on the changes of the weather; and that it's progreſs has been rapid and ſucceſsful, may be ſeen in the works of De Luc, De Sauſſure, Jones, Marſhall, and Kirwan. But theſe obſervations will be ſtill more valuable to poſterity; for we can ſcarce expect them in ſufficient number in our own age, to deduce from them a general and perfect theory.

To attain this end, it will be neceſſary to multiply obſervations on as great a number of ſigns as poſſible; for it is only by their combination and concurrence that we can expect to remove the uncertainty, inſeparable from each in itſelf. Thus the barometer is not always a certain ſign; the ſame may be ſaid of the thermometer, the hygrometer, and the action of winds. But if they all concur together, there is but little chance of being deceived; and there would be ſtill leſs, if to theſe were joined other ſigns, which are eaſy to obſerve, and which by their combination would render our prediction certain.

No ſign, nor any inſtrument of obſervation, ſhould therefore be neglected, either from a love of ideal perfection, or fears of inaccuracy. Thus though the hygrometer be at preſent a very imperfect inſtrument, yet one certain ſign has already been obtained from it's indications, and more may be reaſonably expected. Even the words very dry, very moiſt, moderately dry, moderately moiſt, though of vague determination, may throw much light on the ſtate of the atmoſphere.

It is neceſſary that the obſerver ſhould enter into a preciſe detail of the various ſtates of the ſky, and the clouds. What can we learn from the words covered, and cloudy, or half covered ſky, &c.? Nothing, ſince it is well known, that a covered ſky, in one caſe, is almoſt as certain an indication of fine weather, as in another, it is an indubitable preſage of rain. The accurate obſerver piques himſelf on a thermometer, with which he can obſerve within a degree, and a barometer that he can depend upon to leſs than the 100dth of an inch, but is ſilent on the tranſparency of the air, on dews, on the elevation, the form, the ſign, the diſpoſition, the colour, and the denſity of the clouds, things that may be obſerved with eaſe, and deſcribed without trouble; being attended with no other inconvenience than that of extending the ſize of our meteorological tables.

There is a phenomenon, which has not been ſufficiently attended to, namely, the undulating motion of the firmament, or that diurnal tumult in the air, which is kept up by the heat of the ſun. What the ſun raiſes from the earth by the heat of the day, is ſuſtained in the atmoſphere by it's heat, and the agitation, or expanſive undulation of the air. This motion is often viſible to the naked eye, but in the field of a powerful teleſcope it is very conſpicuous; all objects appear in violent agitation, and the line of the ſenſible horizon, which ought to be clear and well defined, is waved like a field of corn in the wind, or the ſurface of the ſea in a ſtorm. So long as this agitation continues, the vapours ſtay in the air, but when it ſubſides, and the ſun departs, they are condenſed and fall down to the earth in the night as dew.

In the preſent ſtate of this part of ſcience, when we are unacquainted with ſo many phenomena, and ſtill more ignorant of their cauſes, general rules will often be found to fail, and particular ones will, without much circumſpection, prove to be a ſource of error: amongſt the variety of means for predicting the changes of the weather, the barometer is undoubtedly one of the beſt, and is in this, as well as many other reſpects, one of the greateſt acquiſitions to natural philoſophy.

The uſual ranges of the mercurial column in this latitude, are comprized between 28 and 31 inches, of which the middle, or 29½ is conſidered as the variable: I think it ſhould be placed ſomewhat higher. Near the pole, the variations of the barometer are much greater; between the tropics, much leſs.

PROGNOSTICS FROM THE BAROMETER.

1. In general, when the barometer falls, the air being lighter, will let fall it's vapour, and give us rain. But when the mercury riſes, the air being heavier, will ſupport the vapours, and be productive of fine weather.

2. If the mercury falls in a froſt, we may expect ſnow, or a thaw; but if it riſes in winter with a north or eaſt wind, it generally portends a froſt.

3. In order, however, to deduce any obſervations with certainty, we muſt attend to the progreſs of the riſe or fall: thus, if it ſinks ſlowly and gradually, we may expect that the rain will be of ſome continuance. But if the riſe be gradual, we may judge, that the fine weather will be laſting.

4. If the barometer fluctuates much, riſing and falling ſuddenly, the weather is unſettled and changeable.

5. If it falls very low, there will be much rain.

6. But if it's fall be low and ſudden, a high wind generally enſues.

7. When exceeding low, ſtorms and tempeſtuous weather may be expected: but if an extraordinary fall happens, without any remarkable change near at hand, it is probable that there is a ſtorm at a diſtance.

8. The deſcent of the barometer is not, however, always an indication of rain, for it will often fall for wind; nor is it's riſe a certain ſign of fair weather, particularly if the wind be northerly or eaſterly.

9. If the fine weather be laſting, with a weſterly wind, the barometer generally reſts a little above changeable, but ſomewhat below 30 inches.

10. In the ſummer months the barometer does not vary ſo much as in winter.

11. The French writers ſay, that the greateſt elevations of the barometer are in a froſt with a north or eaſt wind.

12. The greateſt variations in the barometer are in the two firſt, and the two laſt months of the year, but particularly in the firſt and laſt.

13. A north-eaſt wind generally makes the barometer in this country riſe, and it is generally loweſt with a ſouth-weſterly wind.

BEIGHTON'S RULES.

If the mercury continues to fall while it rains, it will be likely to rain the next day.

When the mercury is pretty high, and has fallen to foretel rain, and yet riſes before the rain falls, it is an indication that there will be but little of it.

In ſerene and hot weather, when the mercury is high and riſing, and you have all poſſible certainty of fair weather the next day, and yet there ſhould happen to fall very heavy ſhowers, it is probable they have been driven upon you by the effect of diſtant thunder.

In fair weather, when the mercury has continued high and riſing, if it falls about noon, and riſes again towards the evening, a ſingle ſhower may be expected on the evening or noon of the next day, and then fair weather.

When the mercury riſes gradually about half a 10th, and continues to do ſo for many days, the fair weather may be expected to continue for ſome time, unleſs wind intervenes, particularly from the S W by S.

PROGNOSTIC FROM BAROMETER AND THERMOMETER.

If the air in foggy weather becomes hotter by the action of the ſun alone, the fog generally diſſipates, and the air remains ſerene: but if the barometer falls, and the change of temperature be from a ſouth or ſouth-weſt wind, the fog riſes and forms itſelf into clouds, and it's aſcenſion is generally a ſign of rain.

FROM BAROMETER, HYGROMETER, WIND, AND STATE OF THE SKY.

The barometer being high and ſtationary, the natural and factitious hygrometers indicating dry air, the canopy of the ſky lofty, and the wind north-eaſterly, are the ſureſt ſigns of SETTLED FAIR; while a light and moiſt atmoſphere, the canopy of the ſky low, and a ſouth-weſt wind, certainly portend a wet ſeaſon.

FROM VAPOURS.

A ſhepherd in Eſſex had a doctrine which he ſaid was confirmed by long obſervation, that after the ſky had taken up five or ſix fogs, it was pretty ſure to ſend them down again in rain: ſo he made it a practice to keep a regiſter of the fogs upon a ſtick, and according as the numbers ſtood, he predicted when the rain was to follow. There might be ſome foundation for this as a local obſervation, but it cannot be extended, as fogs depend not only upon the ſtate of the air, but alſo upon the ſituation of the place. We have at preſent no data from obſervations, whereby to form certain concluſions relative to fogs, and their connections with rain.

SIGNS FROM THE THERMOMETER ONLY.

In winter, if the cold diminiſhes ſuddenly, it in general portends rain. In ſummer, a ſudden augmentation of heat is a forerunner alſo of rain.

PROGNOSTIC FROM THE HYGROMETER AND THERMOMETER.

It is in moſt caſes a certain ſign of fair weather, when the march of the hygrometer from it's greateſt extreme of humidity in the morning, to the greateſt degree of dryneſs in the afternoon, is greater than it generally makes with the ſame temperature; while the reverſe is one of the moſt certain indications of rain.

PROGNOSTICS FROM THE CLOUDS.

There are ſo many ſigns by which it is ſuppoſed that we may foretel the approaching weather, that Virgil was bold enough to affirm, that no ſhower ever did damage to any man without giving him proper warning: amongſt theſe the ſigns from the clouds are many and important; for from the clouds the rain proceeds, and it is the ſtate of the air with reſpect to the water they contain, that either prevents or haſtens it's fall into rain. "They are continually travelling over all the terreſtrial globe, and by a proper communication of moiſture, render fruitful the ſpacious paſtures of the wealthy, and gladden the cottager's little ſpot. Nay, they SATISFY THE DESOLATE AND WASTE GROUND, AND CAUSE THE BUD OF THE TENDER HERB TO SPRING FORTH: that the natives of the lonely deſert, the herds which know no maſter's ſtall, may nevertheleſs experience the care of an all-ſupporting Parent."

The formation and ſolution of clouds in the ſky are often manifeſt to the ſight, if they are watched attentively for ſome time together; particularly in a ſummer's evening, we ſhall ſee them leſſen by degrees, and be at laſt ſo totally diſſolved in the air as to be no longer viſible. The Rev. Mr. Jones, in his admirable diſquiſitions, to which I am principally indebted for the account of the prognoſtic ſigns of the weather, ſays, that when in company with another obſerver, he has been taking the angles of a cloud at two ſtations, to find their height at different ſeaſons; the cloud fixed upon for his purpoſe has often waſted away and diſappeared entirely before it reached the intended place of obſervation. This reſolution of the clouds into air, and their diſappearance from the ſight, may be conſidered as a ſtrong ſymptom of fair weather.

But on the other hand, when they are collected out of it, and manifeſtly increaſe both in denſity and magnitude, it is a ſtrong prognoſtic of rain. Thus when the ſky, which has been long ſerene and blue, becomes fretted and ſpotted with innumerable ſmall clouds, bearing ſome reſemblance to the waves of the ſea, or the party-coloured back of a mackerel: at firſt they are thin, white, and fleecy; but by degrees grow dark and black, and are in general generated at about the height of three quarters of a mile.

Againſt heavy rain, every cloud riſes bigger than the preceding, and all are in a growing ſtate: this is moſt remarkable on the approach of a thunder-ſtorm, when ſmall fragments of clouds increaſe and aſſemble together, till in a ſhort ſpace of time they cover the ſky. Thus, after a great drought in the days of Elijah, a cloud ſeemed to ariſe out of the ſea (that is, from the horizon of the ſea) no bigger than a man's hand, which ſoon overſpread and blackened the whole heaven.

When the clouds are formed like fleeces, deep and denſe towards the middle, and very white at the edges, with a bright blue ſky about them, they generally ſoon fall in hail, ſnow, or in haſty ſhowers of rain.

If clouds are ſeen to breed high in the air, in thin white trains, like locks of wool or the tails of horſes, they ſhew that the vapour is ſpread and ſcattered by contrary winds above while it is collecting, from which wind will ſoon be produced below, and probably rain with it.

Mr. Jones ſays, that from the complexion of a ſingle cloud, with white edges and dark diverging lines from it, he ventured to predict a high wind forty hours before it began; when there was a ſtorm of the firſt magnitude, which laſted for two days and two nights.

If the clouds, as they come forward, ſeem to diverge from a point in the horizon, a wind may be expected from that or the oppoſite quarter.

When a general cloudineſs covers the ſky above, and there are ſmall black fragments of clouds like ſmoke flying underneath, rain is ſeldom far off, and is generally laſting.

There is no ſign of rain more certain than two different currents of clouds, eſpecially if the undermoſt flies faſt before the wind: two ſuch currents, in hot weather, portend a thunder-ſtorm.

The tranſparency of the air is to the inhabitants of the Alps one of the moſt certain prognoſtics of rain; there, when the diſtant objects appear diſtinct and well defined, when the ſky is of a deep blue, they conſider rain as near at hand, though no other ſigns appear. How far this obſervation may hold, with reſpect to this country, I have had no opportunity of obſerving ſince I began to conſider the ſubject; ſo far, however, may be ſaid, even with reſpect to us, that the cleareſt ſky contains a great quantity of vapour, which is the occaſion of it's blue colour.

Another circumſtance which ſeems to have eſcaped the attention of moſt obſervers, is, the colours which may be ſometimes obſerved in the white clouds immediately under the ſun. By obſerving carefully theſe clouds, we may now and then ſee decided tints of the rainbow, without rain or rainbow; the colours are lively and ſcattered, without any order, about the moſt enlightened or brighteſt part of the cloud. This in Swiſſerland is reckoned to be an infallible ſign of rain.

FROM THE DEW.

If the dew lies plentifully upon the graſs after a fair day, another fair day may be expected; but if after ſuch a fair day there is no dew upon the ground, and no wind ſtirring, it is a ſign that the vapours go upward, and that there will be an accumulation above, which muſt terminate in rain.

If the dew, or hoar froſt, are very abundant at a ſeaſon when they are not generally produced, and the barometer is low, it is in general a ſign of rain.

FROM THE FACE OF THE SKY.

The colour of the ſky is an index to the weather, becauſe it ſhews the ſtate of the vapours which reſide in the atmoſphere.

If the red vapours of the evening are precipitated, the morning ſky is clear; but if they remain in the air, the morning is red, and rain is in general the conſequence.

If a lowring redneſs ſpreads far upwards from the horizon, either in the morning or the evening, it is ſucceeded either by rain or wind, frequently by both.

If ſuch a fiery redneſs extends towards the zenith in an evening, the wind will be high from the weſt, or ſouth weſt, attended with rain, and ſometimes ſucceeded by a flood.

When the ſky in a rainy ſeaſon is tinged with a ſea-green colour near the horizon, when it ought to be blue, the rain will continue and increaſe. If it be of a deep dead blue, it will be ſhowery.

The loftineſs of the canopy, is perhaps one of the trueſt prognoſtics of fine weather.

FROM THE SUN, MOON, AND STARS.

The appearance of the ſun, moon, and ſtars, give notice of approaching changes in the weather, as the rays which come from them to us, muſt paſs through the vapour in the atmoſphere, and indicate it's ſtate.

The ſun riſing gaudily, (the clouds in the eaſt being tinged with an orange colour) is generally eſteemed to be a ſign of rain.

When there is a hazineſs high in the air, the light of the ſun fading by degrees, and his orb looks whitiſh and ill defined, it is in general a ſign of rain.

If the rays of the ſun breaking through the clouds are viſible in the air, and appear like the horns of irradiation which painters place on the head of Moſes, it ſhews the air to be filled with vapour; and if other ſigns concur, is a proof that rain is at hand.

Virgil ſays, that a pale moon is a ſign of rain; that a red one predicts wind; and a white one, and of her natural colour, with a ſerene ſky, fair weather.

If the moon and ſtars grow dim at night, with a hazineſs in the air and a ring, or halo round the moon, it is a ſign of rain. This is not, however, a bad ſign, if it happen in an evening, when the dew is forming; but if they appear at any other time, they prove a general diſpoſition in the air and clouds, to let go their vapours under that form which we denominate rain.

Mr. Jones gives us the following obſervation with reſpect to the moon's monthly courſe.

If the moon be rainy throughout, it will clear up at the enſuing change, and the rain will probably commence again in a few days, and continue: but on the contrary, if it has been fair throughout, and it rains at the change, the fair weather will probably be reſtored about the fourth or fifth day of the moon, and continue as before. By this rule, he ſays, he has made hay theſe twenty years, without having once had the mortification to ſee it damaged by the rain. A farmer who has much work to do, cannot contract it in ſo ſmall a compaſs as to reap much benefit by this obſervation; but a gentleman who cuts hay for his own conſumption, will ſeldom fail to find his account in it

Dr. Horſley attacks this opinion concerning the moon; and though it's influence has attracted the general notice of men in all ages, yet he peremptorily aſſerts, that it is a notion in itſelf improbable, deſtitute of all foundation in phyſical theory, and but little ſupported by any plauſible analogy. But the Doctor himſelf does not deny that the obſervant huſbandman will find a variety of uſeful prognoſtics in the appearances of the moon; but then he ſays, they will be ſymptoms deſtitute of all efficient powers: they will ſhew the preſent ſtate of the air as that on which they depend, not as that which they govern, and may furniſh probable conjectures for two or three days to come.

FROM THE WINDS.

Among the cauſes which affect the weather, there is none whoſe influence is more demonſtrable than that of the winds; theſe, though uncertain in appearance, are, like all other phenomena of nature, governed by fixed and determinate laws, and deſerve a moſt ſerious inveſtigation.

When the wind veers about uncertainly to ſeveral points of the compaſs, rain generally follows. By ſome it has been aſſerted, that if the wind in veering about follows the courſe of the ſun from eaſt to weſt, it brings fair weather; but if it's courſe is from weſt to eaſt, foul.

A whiſtling, howling wind is almoſt an infallible ſign of rain; it is a ſign that does not ſeem to be confined to any climate: for in the ſacred hiſtory we find Elijah ſaying, GET THEE UP, EAT AND DRINK, FOR THERE IS A SOUND OF ABUNDANCE OF RAIN.

SIGNS FROM ANIMALS.

Thoſe who pay attention to the animal creation, will find in their habitudes, many prognoſtics of the changes of the weather. In the nature of their labours, by the uneaſineſs they teſtify, by the peculiar tone of their voice, or by the precautions they take to ſhelter themſelves, their feelings are probably more acute, and their ſenſes more awake to the delicate impreſſions of natural cauſes, than our's, where the mind by it's continual action diminiſhes the force of all external impreſſions.

OF THE SOURCES OF HEAT AND COLD.

If the changes of the weather depended on the courſe of the year, and the temperature of climates were governed by their ſituation with reſpect to the ſun, that is, by their latitude, then the weather might be reduced to ſome regular theory. But this is ſo far from being the caſe, that the latitude of a place cannot be conſidered as an index to the temperature of the climate: for we find the hotteſt days in the coldeſt climates; and the coldeſt weather, and even perpetual ſnow, are found in countries bordering on and immediately under the equator; ſo that we muſt recur to ſome other cauſes beſides the immediate influence of the ſolar rays.

1. But though the ſun is not the only cauſe, it's preſence is undoubtedly the principal ſource of heat as well as light, and it's abſence the primary cauſe of cold. It is indeed the great ſpirit of the world: all things revive at his approach; winter and froſt lay behind him.

2. The ſecond ſource of heat is the earth. Nobody has yet been found ſo abſurd as to ſuppoſe that human perſpiration was owing to the air that ſurrounds the ſkin; it originates in an internal cauſe: it is occaſioned by a heat within, not the air without. It is the ſame with reſpect to the earth; which by imparting it's heat to the atmoſphere, moderates the rigour of the winter's cold. Whether we ſuppoſe that this heat ariſes from a central ſource, or that the globe from it's firſt creation was endued with a heat ſufficient for all the purpoſes it

was intended to anſwer, yet it is evident that it is renewed and preſerved by the influence of the ſun, and that there is always a ſilent and imperceptible heat proceeding from the earth.

3. The next great ſource of heat is the condenſation of vapour. Vapour contains a quantity of fire: it is this fire which cauſes it to aſſume, and ſupports it in an aerial expanded ſtate: when condenſed into a liquid form, it lets go this fire, which warms the ſurrounding atmoſphere: hence the ſultrineſs frequently experienced before rain.

OF THE SOURCES OF COLD.

1. As the earth is one of the principal ſources of heat in the atmoſphere that ſurrounds it, ſo is diſtance from the earth a ſource of cold: the greateſt cold prevailing in the higheſt regions of the atmoſphere: for where the reaction is wanting that is occaſioned by a ſuperficial preſſure, but little effect can be received from the rays of the ſun; and it is further proved by experiments with the burning-glaſs, that a clear unclouded air receives no heat from theſe rays. Hence when we aſcend to a lighter air, at a diſtance from the ſurface, the heat is not ſufficient to melt the ſnow; and we find the higheſt mountains, even under the equinoctial, perpetually covered therewith: thus the mean height of the lower term of congelation in winter, in this latitude, may be conſidered in general to be at 6260 feet from the ſurface, and the mean height of the upper term at 1125 feet. We cannot in this ſhort tract conſider any of the minute exceptions.

2. The next great ſource of cold is evaporation. The ſame cauſe which makes the condenſation of vapour a ſource of heat, makes evaporation productive of cold; as it abſorbs the fire in the latter inſtance, which it gives out in the former: it is this which gives the particles of vapour their aerial form. When fire paſſes from fluids which it has heated, it's courſe is upwards, and it always carries with it a thin ſtratum of the fluid in the form of vapour: thus evaporation not only tempers the heat occaſioned by the ſun's rays, but is one great ſource of cold.

Of Evaporation.

Of evaporation it may be obſerved, 1. That in our climates the quantity of it is four times greater from the 21ſt of March to the 21ſt of September, than it is from the 21ſt of September to the 21ſt of March.

2. That it is greater in proportion as the difference in temperature between the air and evaporating ſurface is greater, though if the air be 15 degrees colder than the evaporating ſurface, there is no evaporation but a depoſit of moiſture from the air.

3. The degree of cold produced by evaporation is always much greater when the air is warmer than the evaporating ſurface, than that which is produced when this ſurface is warmer than the air. Hence warm winds, as the Serocco and Harmatan are more deſiccative than cold winds.

4. Evaporation is more copious when the air is leſs loaded with vapours, and is conſequently powerfully promoted by cold winds flowing into warmer countries.

5. That

5. That it is greatly increaſed by a current of air, or wind flowing over the evaporating ſurface; not only becauſe the evaporating ſurface is thereby increaſed, but alſo becauſe unſaturated air is conſtantly brought into contact with it: hence it is generally remarked, that calm days are the hotteſt.

6. Tracts of land covered with trees, or vegetables, emit more vapour than the ſame ſpace covered with water: on this principle it is, that the air about a wood or foreſt, is made colder by the evaporation from trees and ſhrubs, while the plants themſelves are kept in a more moderate heat, and ſecured from the burning heat of the ſun by the vapour perſpired from their leaves. Thus we find the ſhade of vegetables more effectual to cool us, as well as more agreeable, than that from rocks and buildings.

7. The heat and cold of different countries are tranſmitted from one country to the other by the medium of winds.

Of Annual Temperature.

Within 10 degrees of the pole there is very little difference in the annual temperature, nor is there much within 10 degrees of the equator.

The temperature of different years differs very little near the equator, but they differ more and more as their latitudes approach the pole.

It ſcarce ever freezes, unleſs in very elevated ſituations, in latitudes under 35°, and it ſcarce ever hails in latitudes higher than 60°.

Between the latitudes of 35 and 60, in places adjacent to the ſea, it generally thaws when the ſun's altitude is 40°, and ſeldom begins to freeze until the ſun's meridian altitude is below 40°.

The greateſt cold in all latitudes in our hemiſphere, is generally about half an hour before ſun-riſe: the greateſt heat in all latitudes between 60° and 45°, is found to be about half paſt two o'clock in the afternoon.

The coldeſt weather in all climates generally prevails about the middle of January, the warmeſt in July.

The temperature of a climate depends on many circumſtances, particularly on the diſpoſition of the land; as it's elevation, it's expoſure to the winds, and the courſe of the mountains that are found in it. Thus the writer of Anſon's Voyage informs us, that while they coaſted near the land of South America, which has thoſe vaſt ridges of mountains, the Andes and Cordillieras, the air was rendered temperate by the wind that blew over them; but when they had paſſed beyond this tract of land, and ſailed by the iſthmus of Darien, where the country is flatter, the air became inſupportably cloſe and ſultry.

All countries lying to the windward of high mountains, or extenſive foreſts, are warmer than thoſe to the leeward in the ſame latitude.

The vicinity to the ſea is another circumſtance which affects the temperature of a climate; as it moderates the heats from the land, and brings the atmoſphere down to a ſtandard beſt fitted to the human conſtitution: this is probably the reaſon why there is ſo great a proportion of ſea on the terraqueous globe, and particularly why it is ſo largely diſtributed about the middle region of the earth. In our hemiſphere, countries that lie ſouthward of any ſea are warmer than thoſe that have that ſea to the ſouth of them; becauſe the winds that ſhould cool them, in winter are mitigated by paſſing over the ſea; whereas thoſe that are northward of the ſea, are cooled in ſummer by the breezes from it. A northern, or ſouthern bearing of the ſea, renders a country warmer than an eaſtern or weſtern bearing.

Iſlands participate more of temperature ariſing from the ſea, and are therefore warmer than continents. Moſt large iſlands have their greateſt extent from north to ſouth. With us, the ſouthern parts are proportionably colder than the northern. A ridge of mountains generally traverſes iſlands in the direction of their length.

The ſoil of large tracts of land has it's ſhare in influencing the temperature of the weather: thus ſtones, or ſand, heat and cool more readily, and to a greater degree, than the earth or vegetable mould: hence the violent heats of the moſt ſandy deſarts of Arabia and Africa, and the burning heat and blaſting qualities of the wind that paſſes over them: hence alſo the intenſe cold of Terra del Fuego, and other ſtony countries in cold latitudes.

Living vegetables have a conſiderable effect in altering climates and affecting the weather. Wooded countries are much colder than thoſe that are open and cultivated: thus part of Guiana has only been cleared from wood ſince the beginning of this century, and the heat in that part is already exceſſive; whereas in the wooded parts the inhabitants are obliged to light a fire every night.

Sir William Young gives a remarkable inſtance of the effect of hills in arreſting vapours, and producing rain; while the exhalations from the trees on it's ſurface cool and temper the air: obſerving, that the ſmooth poliſhed Barbadoes and our Leeward iſlands are parched up, whilſt the towering and rugged Dominica, St Vincent, Grenada, and Tobago, enjoy inceſſant rains, and delicious verdure.

It is generally agreed, that the clearing away of wood in time leſſens the vapours, and conſequently the rain of a country. Several fine pariſhes in Jamaica, which uſed to produce large crops of ſugar canes, and were once the richeſt ſpots in the iſland, are now dry for nine months in the year, and are turned into cattle pens, through the clearing away of the neighbouring woods.

The following obſervations on the ſame ſubject were communicated to me by a very ingenious friend.

Water is very plentiful in thoſe countries where woods and foreſts abound, and the pureſt ſprings are generally found beneath the friendly ſhelter of a grove.

The natural hiſtory of every country ſhews, that in proportion as the woodlands are cleared, the water courſes diminiſh.

In America, unfortunately for the inhabitants, this truth is too well known. For ſince the woods in the vicinity of their towns have been cut down, many long eſtabliſhed mill races have become dry, and others have been reduced ſo low as to cauſe very great interruptions to the miller, who muſt wait a conſiderable time for the dams to fill between every few hours work.

Hence we may learn the important neceſſity of preſerving the trees, from beneath whoſe humid ſhades a water ſpring diſcharges it's ſtreams: and hence too we may learn, that the ſmalleſt ſprings may be improved by planting around them a grove of trees, particularly the oak, ſo highly valued by the Greeks, the Romans, and our ancient Druids who, conſidering the health of man, and the fertility of the ſoil to be abſolutely dependent upon plenteous ſtreams of water, CONSECRATED THEIR GROVES to preſerve their ſprings.

It were much to be wiſhed that ſome expedient could now be formed to anſwer the ſame valuable purpoſe.

I ſhall finiſh this little tract with an extract on the connection between the human body and the weather from Mr. Jones's Phyſiological Diſquiſitions.

The air affects the human frame, by it's weight, it's moiſture, it's dryneſs, it's heat, and it's cold. There are two forces which act upon the animal frame, and they are both equally neceſſary to the keeping up of vital heat and vital motion. The one force is that of the atmoſphere preſſing without upon the ſurface of the body; the other is that of the air expanding it within; and theſe two ought to be a counterbalance to each other. When the barometer is high, the ſuperficial preſſure is in force on the outſide of the body, by which the fibres are ſtrengthened; the coats of the veſſels react upon their contents, the blood is propelled, ſecretions are promoted, the body feels active, and the mind is in vigour; athletic conſtitutions, inured to the inclemency of the weather, feel little or no inconvenience from any change; but when the frame is tender, or ſickly, it is ſenſible of depreſſion and relaxation, when the weight of the air is leſſened: the force within is not ſufficiently counterbalanced, the reaction of the ſolids upon the fluids is weaker, the coats of the veſſels are diſtended, the muſcular parts inflated, the body leſs active, and the faculties leſs vigorous than uſual.

When the air is too moiſt, it draws off the vital heat, occaſions a ſenſation of cold and chillneſs over the ſkin, checks perſpiration, impoveriſhes the blood, and by increaſing the ſerous fluid, brings on agues, intermittents, dropſies, putrid ſore throats, &c. While air which is too dry, as is ſometimes the caſe with a north, or north eaſt wind, by carrying off the finer parts of the animal fluids in perſpiration, occaſions a viſcidity of the blood, and a variety of diſtempers, according to the different conſtitutions of the body.

Of ſituations, perhaps, the moſt promiſing for the enjoyment of health, life, and every convenience, is near the bottom of an high hill, that has a ſoutherly aſpect, with woods and plantations about the head of it; a dry ſoil of ſand or gravel, with a mixture of loam, and running waters, with green meadows before it; or the ſea, with a ſteep and clear ſhore of gravel or beach. There may Health fix her ſeat; but let no man think that his ſituation will preſerve him, unleſs he has the prudence to preſerve himſelf. All the varieties of the weather, all the ſeaſons, and all the elements, are at war with the indolent and the intemperate.

The General State of the Weather when the Mercury in the Barometer remains stationary on any of the under-mentioned Degrees, 12 of which are equal to an English Inch

The outer numbers are the correſponding inches and parts.

31 inch.	16.	Settled, fine clear ſky.
.92	15.	Summer; very warm; winter, hard froſt.
.83	14.	Great drought.
.75	13.	Pleaſant ſerene weather.
.67	12.	Settled.
.58	11.	Summer, cloſe and rainy; winter, ſnow, and foggy.
.50	10.	Clear.
.42	9.	Rain or wind; winter, ſnow or miſt.
.33	8.	Fine weather.
.25	7.	Rain or wind.
.17	6.	Good but uncertain weather.
.08	5.	Generally miſty when the thermometer is under 60 deg.: otherwiſe, thick, rain or wind; but in ſummer with an eaſterly-wind, clear.
30 inch.	4.	Good weather.
.92	3.	Stormy with a north-weſterly wind; otherwiſe, raw, hazy, cloudy weather; in ſummer, thunder.
.83	2.	Moderate weather.

.75	1.	Rain, thunder, wind; in winter, with a northerly wind, raw, cold, ſnow, or miſt.
.67	0.	Variable.
.58	1.	Moderate; if the wind be ſoutherly, rain.
.50	2.	Rain, wind, thunder, hail, ſnow, &c.
.42	3.	Calm, but generally with heavy clouds.
.33	4.	Rain, wind, thunder, hail, ſnow.
.25	5.	Tolerably calm.
.17	6.	Heavy rain, or wind, thunder, hail, ſnow, &c.
.08	7.	Serene, though ſometimes fogs or miſt.
29 inch.	8.	Stormy; in winter, miſt.
.92	9.	Calm; in winter, thick fog.
.83	10.	Heavy Storms.
.75	11.	Calm.
.67	12.	Stormy.
.58	13.	Calm, but heavy clouds.
.50	14.	Half a hurricane.
.42	15.	Calm, with a great drift of ſcudding clouds.
28.33	16.	Violent hurricane.

Thus the barometer ſtood, 12th December 1747.

Theſe obſervations were made when the barometer was placed 25 feet above the level of the ſea or river waters.

Before each obſervation, it will be requiſite to rap the caſe with the knucles, to remove the friction of the mercury; thence you may be certain whether the mercury has been ſtationary on any degree.

When the mercury reſts at ½ a degree, expect variable, or a mixture of that weather expreſſed by the degree above and below it.

It is moſt adviſeable to obſerve the alteration in the riſe and fall of the mercury every three hours; as at 6, 9, 12, &c.

I found this ſtate of the weather among my Father's papers.

A SCALE OF HEAT.

	Fahrenheit's Degrees.
Iron in fuſion about	3000
Iron with the white ſparkling heat of a ſmith's forge	2780
Iron with a heat almoſt white	2080
The heat of live coals without blowing, perhaps about	1650
Iron with a glowing red by day light	1600
Iron juſt red hot by day light	1120
Iron juſt red hot in the dark	1000
Greateſt heat of lead in fuſion	820

	Fahrenheit's Degrees.
Colours of iron are burned off	800
Mercury boils, by ſome placed at 600; by Jones	700
Poliſhed iron takes a full blue	700
Poliſhed iron takes a purple	660
Linſeed oil boils	620
Lead melts	610
Poliſhed iron takes a ſtraw colour	605
Oil of vitriol boils	546
Braſs takes a blue colour	500
Tin melts	490
Tin foil and biſmuth	450
Braſs takes a copper colour	415
Poliſhed braſs takes a gold colour	340
Spirit of nitre boils	242
Water boils at a mean ſtate of the atmoſphere	212
Freſh human urine boils	206
Brandy boils	190
Alcohol boils	176
One pound of water of 52°, to ½ a ℔ of freſh chalk lime	182
1 oz. of water of 54°, to ½ oz. of oil of vitriol	170
Serum of blood and white of eggs harden	156
Bees wax melts	145
Greateſt heat of a bath which the hand can well bear	114
Heat of the Serocco wind at Palermo in Sicily	112
Heat of a hen hatching eggs, from 92, to	108
Heat of the ſkin in ducks, geeſe, hens, pidgeons	107
Heat of the human ſkin in an ague, fever	106

	Fahrenheit's Degrees.
Heat of the ſkin in dogs, cats, ſheep, and other quadrupeds	103
Heat of the human ſkin in health	98
Heat of a hive of bees	97
Heat of the air in the ſhade in very hot weather	80
Butter begins to melt	74
Temperate	55
Oil of olives begins to ſtiffen	43
Water juſt freezing, or ice juſt melting	32
Milk freezes	30
Urine and common vinegar freeze	28
Good burgundy, claret, and madeira, freeze	20
One part of ſpirit of wine, with 3 of brandy, freezes	7
A mixture of ſnow and ſalt	0
Mercury freezes	39

With reſpect to the formation of this table, ſee Jones's Phyſiological Diſquiſitions.

OF MEASURING HEIGHTS BY THE BAROMETER.

The barometer is the only inſtrument that can be conveniently uſed for this purpoſe in great and diſtant tracts of country. The method of uſing it is eaſy, only requiring a little habit, and ſome attention; while few will go to the expence, or attend to the adjuſtments neceſſary for an accurate geometrical menſuration of heights; and there are few ſituations in mountainous countries that afford a proper baſe. The barometrical obſervations require no peculiarly favorable circumſtances in the figure or ſituation of the mountain to be meaſured; it is ſufficient that both ſituations be acceſſible.

In order to meaſure heights accurately by the barometer, it is neceſſary to be provided with two barometers, made for that purpoſe, of the beſt conſtruction, with a nonius, by which the length of the mercurial column is aſcertained to the 500dth part of an inch. There ſhould be four thermometers, one attached to each barometer, and two detached therefrom.

1. Place one of the barometers, with it's attached and detached thermometer, on the given eminence in the ſhade, while the other is in the valley, or plain, at the bottom of the hill. Here they muſt remain a ſufficient time for the detached thermometer to acquire the temperature of the air.

2. As ſoon as the thermometer is fixed, obſerve the height of the mercurial column, and the temperature of the two thermometers. Similar obſervations ſhould be made, at the ſame time, by the obſerver on the plain. It is adviſeable to take three or four ſets of obſervations at ſhort intervals of time, at each ſtation, and to uſe the mean of the whole as the true obſervation.

3. To reduce the temperature of the mercury in each barometer to the mean height of 55°, take the difference between the two attached thermometers, and ſeek in table 1, the degrees of heat in the column on the left hand, and take out the number in the ſame line with this, but under the height of the barometer, in inches, in the horizontal line at top. The number thus found is the correction for the expanſion of the quickſilver, by heat expreſſed in thouſandth parts of an inch, to be added to the coldeſt barometer, or ſubtracted from the hotteſt, will give the height of the two barometers, ſuch as would have obtained had both been expoſed to the ſame temperature.

4. Take the difference of the logarithms of theſe corrected heights of the barometers, and the four firſt figures on the left will be the logarithmic elevations in fathoms, the remaining figures being a decimal: this may be reduced to feet by multiplying it by ſix, and the number found will be the true elevation, if the mean temperature was 31° ¼.

5. To find the mean temperature, add together the degrees of the two detached thermometers, and divide their ſum by two, the quotient will be an intermediate to be taken for the mean temperature of the vertical column of air intercepted between the two places of obſervation. If it be 31° ¼, no correction is required; but if not, take it's difference from 31° ¼, and with this difference ſeek the correction in table 2.

Look for the number of degrees in the left hand column, and the height found to the neareſt thouſand of feet in the horizontal line at top. For the hundred feet

ſtrike

off one cypher to the right hand, for the tens ſtrike off two, for the units three. The ſum of theſe numbers is to be added to the height, if the temperature be greater than 31° $\frac{1}{4}$; but ſubtracted if leſs, which will give the correct height in Engliſh feet.

EXAMPLE.

Barometer	Therm. attached	Diff.	Therm.	Mean heat
Lower 29.400	50	4	45	42$\frac{1}{4}$
Higher 25.190	46		39$\frac{1}{2}$	

Log. of lower Br. 29.400	is	4683473
Log. of upper Br. 25.200	is	4014005
Difference		669.468
		6
Approximate height		4016.708
		+ 107.474
Correct height		4124.108

Correc. for the diff. between the 2 attached Ther. 4° gives 10 to be added to the coldeſt.

$$\begin{array}{r} 25.190 \\ +\ 10 \\ \hline 25.200 \end{array}$$

31$\frac{1}{4}$ Standard heat from 42$\frac{1}{4}$ gives 11 for 2d correction.

11 on 4000 feet	106.9
16	5
	107.4

TABLE I.

For the EXPANSION of QUICKSILVER by HEAT.

By Sir GEORGE SHUCKBURGH.

Degr. of the Therm.	Height of the Barometer in Inches.												
	20	21	22	23	24	25	26	27	28	29	30	31	32
1	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2
2	4.1	4.3	4.5	4.7	4.9	5.1	5.3	5.5	5.7	5.9	6.1	6.3	6.5
3	6.1	6.4	6.7	7.0	7.3	7.6	7.9	8.2	8.5	8.8	9.1	9.4	9.7
4	8.1	8.5	8.9	9.3	9.7	10.1	10.5	11.0	11.4	11.8	12.2	12.6	13.0
5	10.1	10.6	11.1	11.6	12.1	12.7	13.2	13.7	14.2	14.7	15.2	15.7	16.2
6	12.2	12.8	13.4	14.0	14.6	15.2	15.8	16.4	17.0	17.6	18.2	18.8	19.5
7	14.2	14.9	15.6	16.3	17.0	17.7	18.4	19.2	19.8	20.6	21.3	22.0	22.7
8	16.2	17.0	17.8	18.6	19.4	20.2	21.0	21.9	22.7	23.5	24.3	25.2	25.9
9	18.2	19.2	20.1	21.0	21.9	22.8	23.7	24.6	25.6	26.5	27.4	28.3	29.2
10	40.3	21.3	22.3	23.3	24.3	25.3	26.3	27.4	28.4	29.4	30.4	31.4	32.4
11	22.3	23.4	24.5	25.6	26.7	27.8	28.9	30.1	31.2	32.3	33.4	34.5	35.6
12	24.3	25.6	26.8	28.0	29.2	30.4	31.6	32.9	34.1	35.3	36.5	37.6	38.9
13	26.3	27.7	29.0	30.3	31.6	32.9	34.2	35.6	36.9	38.2	39.5	40.8	42.1
14	28.4	29.8	31.2	32.6	34.0	35.4	36.8	38.4	39.8	41.2	42.6	43.9	45.4
15	30.4	31.9	33.4	34.9	36.4	37.9	39.4	41.1	42.6	44.1	45.6	47.1	48.6
16	32.4	34.1	35.6	37.2	38.8	40.5	42.0	43.8	45.4	47.0	48.6	50.3	51.8
17	34.5	36.2	37.9	39.6	41.3	43.0	44.7	46.6	48.3	50.0	51.7	53.4	55.1
18	36.5	38.3	40.1	41.9	43.7	45.5	47.3	49.3	51.1	52.9	54.7	56.5	58.3
19	38.5	40.5	42.3	44.2	46.1	48.1	49.9	52.1	54.0	55.9	57.8	59.7	61.6
20	40.6	42.6	44.6	46.6	48.6	50.6	52.6	54.8	56.8	58.8	60.8	62.8	64.9
21	42.6	44.7	46.8	48.9	51.0	53.2	55.2	57.5	59.6	61.7	63.8	65.9	68.1
22	44.6	46.9	49.1	51.3	53.5	55.7	57.9	60.3	62.5	64.7	66.9	69.0	71.4
23	46.6	49.0	51.3	53.6	55.9	58.2	60.5	63.0	65.3	67.6	69.9	72.2	74.6
24	48.6	51.1	53.5	55.9	58.3	60.8	63.1	65.8	68.2	70.6	73.0	75.4	77.8
25	50.7	53.2	55.8	58.2	60.7	63.2	65.7	68.5	71.0	73.5	76.0	78.5	81.1
26	52.7	55.4	58.0	60.5	63.1	65.8	68.3	71.2	73.8	76.4	79.0	81.6	84.3
27	54.7	57.5	60.3	62.9	65.6	68.3	71.0	74.0	76.7	79.4	82.1	84.8	87.5
28	56.8	59.6	62.5	65.2	68.0	70.8	73.6	76.7	79.5	82.3	85.1	87.9	90.7
29	58.8	61.8	64.7	67.5	70.4	73.3	76.2	79.5	82.4	85.3	88.2	91.1	94.1
30	60.8	63.9	66.9	69.9	72.8	75.9	78.9	82.2	85.2	88.2	91.2	94.1	97.3
31	62.8	66.0	69.1	72.2	75.2	78.4	81.5	84.9	88.0	91.1	94.2	97.4	100.5
32	64.8	68.2	71.4	74.6	77.7	81.0	84.2	87.7	90.9	94.1	97.3	100.5	103.8
33	66.9	70.3	73.6	76.9	80.1	83.5	86.8	90.4	93.7	97.0	100.3	103.6	107.0
34	68.9	72.4	75.8	79.2	82.5	86.1	89.4	93.2	96.6	100.0	103.4	106.7	110.3
35	70.9	74.5	78.0	81.5	84.0	88.6	92.0	95.9	99.4	102.9	106.4	109.9	113.5
36	73.0	76.7	80.2	83.8	86.4	91.1	94.6	98.6	102.2	105.8	109.4	113.1	116.8
37	75.0	78.8	82.5	86.2	88.9	93.6	97.3	101.4	105.1	108.8	112.5	116.2	120.0
38	77.0	80.9	84.7	88.5	91.3	96.2	99.9	104.1	107.9	111.7	115.5	119.3	123.2
39	79.0	83.1	86.9	90.8	93.7	98.7	102.5	106.9	110.8	114.7	118.6	122.5	126.5
40	81.1	85.2	89.2	93.2	97.2	101.2	105.2	109.6	113.6	117.6	121.6	125.6	129.7

TABLE II.

For the EXPANSION of the AIR, or CORRECTING of the UPPERMOST HEIGHT.

By Sir GEORGE SHUCKBURGH.

Deg.	Approximate Height in Feet.								
0	1000.	2000.	3000.	4000.	5000.	6000.	7000.	8000.	9000.
1	2.4	4.9	7.3	9.7	12.1	14.6	17.0	19.4	21.9
2	4.9	9.7	14.6	19.4	24.3	29.2	34.0	38.9	43.7
3	7.3	14.6	21.9	29.2	36.4	43.7	51.0	58.3	65.6
4	9.7	19.4	29.2	38.9	48.6	58.3	68.0	77.8	87.5
5	12.1	24.3	36.4	48.6	60.7	72.9	85.0	97.2	109.3
6	14.6	29.2	43.7	58.3	72.8	87.5	102.0	116.6	131.2
7	17.0	34.0	51.0	68.0	85.0	102.1	119.0	136.1	153.0
8	19.4	38.9	58.3	77.8	97.1	116.6	136.0	155.5	174.9
9	21.9	43.7	65.6	87.5	109.3	131.2	153.0	175.0	196.8
10	24.3	48.6	72.9	97.2	121.5	145.8	170.1	194.4	218.7
11	26.7	53.5	80.2	106.9	133.6	160.4	187.1	213.8	240.6
12	29.2	58.3	87.5	116.6	145.8	175.0	204.1	233.3	262.4
13	31.6	63.2	94.8	126.4	157.9	189.5	221.1	252.7	284.3
14	34.0	68.0	102.1	136.1	170.1	204.1	238.1	272.2	306.2
15	36.4	72.9	109.3	145.8	182.2	218.7	255.1	291.6	328.0
16	38.8	77.8	116.6	155.5	194.3	233.3	272.1	311.0	349.9
17	41.3	82.6	123.9	165.2	206.5	247.9	289.1	330.5	371.7
18	43.7	87.5	131.2	175.0	218.6	262.4	306.1	349.9	393.6
19	46.1	92.3	138.5	184.7	230.8	277.0	323.1	369.4	415.5
20	48.6	97.2	145.8	194.4	243.0	291.6	340.2	388.8	437.4
21	51.0	102.1	153.1	204.1	255.1	306.2	357.2	408.2	459.3
22	63.5	106.9	160.4	213.8	267.3	320.8	374.2	427.7	481.1
23	55.9	111.8	167.7	223.6	279.4	335.3	391.2	447.1	503.0
24	58.3	116.6	175.0	233.3	291.6	349.9	408.2	466.6	524.9
25	60.7	121.5	182.2	243.0	303.7	364.5	425.2	486.0	546.7

TABLE II. continued.

Deg.	Approximate Height in Feet.								
0	1000.	2000.	3000.	4000.	5000.	6000.	7000.	8000.	9000.
26	63.1	126.4	189.5	252.7	315.8	379.1	442.2	505.4	568.6
27	65.6	131.2	196.8	262.4	328.0	393.7	459.2	524.9	590.4
28	68.0	136.1	204.1	272.2	340.1	408.2	476.2	544.3	612.3
29	70.4	140.9	211.4	281.9	352.3	422.8	493.2	563.8	634.2
30	72.9	145.8	218.7	291.6	364.5	437.4	510.3	583.2	656.1
31	75.3	150.7	226.0	301.3	376.6	452.0	527.3	602.6	678.0
32	77.8	155 5	233.3	311.0	388.8	466.6	544.3	622.1	699.8
33	80.2	160.4	240.6	320.8	400.9	480.1	561.3	641.5	721.7
34	82.6	165.2	247.9	330.[illegible]	413.1	495.7	578.3	661.0	743.6
35	85.0	170.1	255.1	340.2	425.2	510.2	595.3	680.4	765.4
36	87.4	175.0	262.4	349.9	437.3	524.8	612.3	699.8	787.3
37	89.9	179.8	269.7	359.6	449.5	539.4	629.3	719.3	809.1
38	92.3	184.7	277.0	369.4	461.6	553.9	646.3	738.7	831.0
39	94.7	189.5	284.3	379.1	473.8	568.5	663.3	758.2	852.9
40	97.2	194.4	291.6	388.8	486.0	583.2	680.4	777.6	874.8
41	99.6	199.3	298.9	398.5	498.1	597.8	697.4	797.0	896.7
42	102.1	204.1	306.2	408.2	510.3	612.4	714.4	816.5	918.5
43	104.5	209.0	313.5	418.0	522.4	626.9	731.4	835.9	940.4
44	106.9	213.8	320.8	427.7	534.6	641.5	748.4	855.4	962.3
45	109.3	218.7	328.0	437.4	546.7	656.1	765.4	874.8	984.1
46	111.7	223.6	335.3	447.1	558.8	670.7	782.4	894.2	1006.0
47	114.2	228.4	342.6	456.8	571.0	685.3	799.4	913.7	1027.8
48	116.6	233.3	349.9	466.6	583.1	699.8	816.4	933.1	1049.7
49	119.0	238.1	357.2	476.3	595.3	714.4	833.4	952.6	1071.6
50	121.5	243.0	364.5	486.0	607.5	729.0	850.5	972.0	1093.5

BRITISH 4 OC 70 MUSEUM

A LIST

OF

METEOROLOGICAL INSTRUMENTS

MADE AND SOLD BY

GEORGE ADAMS,

Mathematical Inſtrument-maker to His MAJESTY, and Optician to His ROYAL HIGHNESS the PRINCE of WALES.

A Plain portable barometer	2	2	0
Ditto with a thermometer	3	3	0
A plain barometer, covered frame and glaſs door	2	12	6
Ditto with a thermometer	3	13	6
A barometer with a long cylindric thermometer	4	4	0
A ditto with ditto, and De Luc's hygrometer	7	7	0
A barometer and thermometer, with a guage, the indexes moving by rack-work	5	15	6
Ditto neater	6	16	6
A barometer for meaſuring the altitude of mountains, &c.	9	9	0
Marine barometers			
Diagonal, wheel, and ſtatical barometers			
Fahrenheit's thermometers, from 1l. 1s. to	2	12	6
Ditto for botanic purpoſes	0	18	0
Ditto for the brewery	1	1	0
De Luc's hygrometer; theſe are the only inſtruments by which comparative obſervations can be made on the dryneſs and moiſture of the air, from 3l. 3s. to	7	7	0
Rain guages	0	18	0
Dr. Lind's wind guage			
Hygrometers with the head of the wild oat	0	10	6
Fontana's eudiometer for aſcertaining the purity of the air	2	5	0